TEPPERELLA TRILINEATA CAM., A WASP CAUSING GALLING OF THE FLOWER BUDS OF *ACACIA DECURRENS*.

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(Plate xx; 9 Text-figures.)

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Introduction.

Actually the observations in this thesis terminated on 7th May, 1937, but the writer continued the study until the adult wasps emerged in September, 1937, and the additional data are included here.

The galls under discussion were first noticed by the writer at Lindfield, Sydney, in August, 1933, on *Acacia decurrens* var. *pauciglandulosa* (Plate xx, figs. 4 and 5). The tree on which the galls were present was very old and the trunk and limbs were heavily infested with both coleopterous and lepidopterous borers which, even at that time, had caused the death of a number of limbs, while the tree, as a whole, was in an unthrifty condition. In January, 1938, the tree died.

General observations on the development of the galls, and the emergence of adult insects, were made during 1934, and it was found that a number of species of wasps emerged, that the life cycle was, at least in the predominant species, annual, and that emergence of the insects commenced in the spring.

In the spring of 1935, prior to the emergence of any adults, a large number of galls were collected and retained in glass jars, and it was found that a remarkable number of species of insects emerged from the galls, but three chalcid wasp species far outnumbered all others. These three species were *Tepperella trilineata* Cam., *Megastigmus* sp., and *Eurytoma* sp., the latter species outnumbering the other two combined.

The species of *Megastigmus* and *Eurytoma* just mentioned were submitted to Dr. A. B. Gahan, Senior Entomologist of the United States Department of Agriculture, who stated that they were dissimilar to any species in these genera in the collections of the United States National Museum, and he expressed the opinion that they were probably new.

The writer has since compared both species with all available descriptions of species in these two genera described from Australia and has concluded that both species are new. These two species will be described in detail in papers concerning their morphology and biology which are shortly to be published.

Early in 1936 a complete study of the three predominant species was commenced and was continued until the emergence of the adults in the spring and summer of 1937. Large numbers of galls were collected in the spring of 1936 and a detailed record was kept of all species emerging.

* This is one of ten papers on Australian Chalcidoidea submitted to the University of Sydney in fulfilment of the requirements for the degree of Doctor of Science in Agriculture.

Of a total of 3,511 adult wasps which emerged, 3,327 comprised the three predominant species previously mentioned; 101 were *Coelocyba nigrocincta*, another chalcid species, while the remaining 83 individuals comprised a further eight wasp species, making a total of twelve hymenopterous species bred from the galls.

Of these twelve species, ten were Chalcids, one was a Braconid, and one was a Bethylid. There is little doubt that the Braconids and Bethylids, which were few in number, were primary parasites of a species of lepidopterous larva, which was at times found feeding in the galls.

As a result of the investigations of the writer the detailed life-histories of the three predominant chalcid species have been elucidated, and at the same time some information concerning the other species of gall inhabitants has been obtained.

Acacia decurrens, which is a bipinnate species of wattle, occurs in New South Wales, and also in Queensland, Victoria, and Tasmania, being predominantly a coastal species, but extending also to the Tablelands. Buds appear several months before flowering and specimens in the collections at the Sydney Botanic Gardens obtained from many localities in New South Wales were in flower in December.

A. decurrens var. *pauciglandulosa* grows very abundantly in the coastal districts in the vicinity of Sydney, and this variety is particularly common in the northern suburbs of Sydney. Many hundreds of trees of various ages were examined in this area, but on comparatively few were galls found, and even then only in small numbers. The one exception was the tree first mentioned, growing near the home of the writer at Lindfield.

Each year since 1933 this tree has carried countless thousands of galls. From May to December, 1936, many hundreds of galls were dissected in order to observe the stages of the various insects present and, in addition, in the spring 2,668 galls were picked from the same tree in order to obtain detailed emergence records, and yet all these galls represented only an infinitesimal proportion of the total number of galls originally on the tree. Thus it was possible to make periodical dissections of large numbers of galls over a twelve months period, without unduly diminishing the insect population, and this original heavily-galled tree has been utilized for practically all the investigations set out in this paper.

Trees of the same variety of *Acacia* have been growing within sixty yards of this tree, which has been galled for a number of years, and yet no galls have ever been found on these. At the time Cameron (1912) described *Tepperella trilineata* it was stated to have been bred from galls on *Acacia decurrens*, but no evidence was brought forward to show that, of the many species occurring in the galls, *T. trilineata* was really responsible for the primary gall formation.

In the spring of 1936, as the three main species emerged from the galls, numbers of each were enclosed in large cellophane sleeves on twigs and limbs of vigorous growing young acacias of the same variety growing in the home of the writer, and which, at the time, were free of galls. Small sleeves fifteen inches in length and six inches in diameter, and larger sleeves up to three feet in length and one foot in diameter, were used in these experiments, and altogether many hundreds of adult wasps of the three species were used. It was found that females of *Tepperella trilineata* would readily oviposit in the minute flower buds, but *Megastigmus* sp. and *Eurytoma* sp. never oviposited when enclosed with similar uninfested limbs. It was noted in these tests that when the adults of *T. trilineata* were first enclosed in these cellophane sleeves, they, in most cases, made their way to the top of the sleeve, and displayed no interest though suitable buds for oviposition were only a few inches away. To ensure that oviposition took place it was found advisable to use a camel-hair brush and with the point of this, transfer the adult females direct from the tubes to suitable buds, and they then, usually, immediately commenced to oviposit.

T. trilineata females also oviposited readily in small buds picked off uninfested trees and enclosed in small glass tubes two inches in length and half an inch in diameter. However, in spite of this heavy oviposition by *T. trilineata*, most of the flower buds on these enclosed branches blossomed and fell, and though some flowers appeared to be slightly aborted, no galls developed on these vigorous young trees.

In the spring of 1937, at the time the adults commenced to emerge, and periodically for the next six weeks, twigs bearing large numbers of galls were tied to the uninfested *A. decurrens* trees of the same variety, growing in the writer's home, but again no galls formed. In 1936 and again in 1937, these young trees flowered within a few days of the heavily-galled tree, so that abundant buds at a suitable stage for oviposition were available. Factors inhibiting the production of galls on these trees are not clear. It is possibly connected with a condition of the sap in the young vigorous-growing trees, while the possibility of the existence of strains within the variety *pauciglandulosa* must not be overlooked.

Though the writer has not experimentally produced galls using *Tepperella trilineata*, there are many points which indicate its primary character. In the first place, it was the only species tested which would oviposit in acacia buds in which no other species had previously laid. Again, during the course of the work, thousands of gall cells were examined and, at least early in the development of the galls, *T. trilineata* was present in all gall cells. In many typical galls *T. trilineata* was the only species found, and examination of cells in these particular galls failed to reveal any evidence of any other species ever having been present.

It was found that when the acacia bud galls were in their very early stages and when the wasps were in the minute egg or early larval stages, even dissection with fine scalpels and needles under the microscope was extraordinarily difficult. The exact location of the insects in the galls could never be determined and they were frequently injured or destroyed during the dissection. Eventually the writer found that by holding the buds in the fingers under the high power of the binocular microscope and, with a razor, cutting extremely thin sections off the gall, it was possible to cut down until portion of the insect egg or larva was just visible. With the point of a cataract knife the plant tissues could then be chipped away and the egg or larva could eventually be completely exposed, and usually was in an uninjured condition.

The species under discussion is at present placed in the family Perilampidae, but both Dr. A. B. Gahan and Mr. A. A. Girault, formerly of the Queensland Department of Agriculture, have informed the writer that they doubt the correctness of this placement. The genus *Tepperella* was established by Cameron (1911), the type species being *T. maculiscutis*, which was bred from galls on *Eucalyptus leucoxylon* in South Australia. Since that time *T. trilineata* has been described, but these are the only two species so far recorded in this genus. Thus the genus is at present confined to Australia and both the species so far recorded have been bred from galls.

T. trilineata has been recorded from Tasmania and Victoria (Cameron, 1912), and the writer has bred this species from galls on *Acacia decurrens* collected at Wyong on the Coast, Blaxland on the Blue Mountains, and Bathurst on the Central Tablelands of New South Wales.

Morphology.

The Adult.

♀.—The adult female (Fig. 1) which was described by Cameron (1912) is a rather robust yellow and black wasp. Its average length is 2·76 mm., the maximum being 2·97 mm. and the minimum 2·55 mm. When at rest it has the abdomen deflected downwards at an angle to the thorax. When alive, the eyes and ocelli

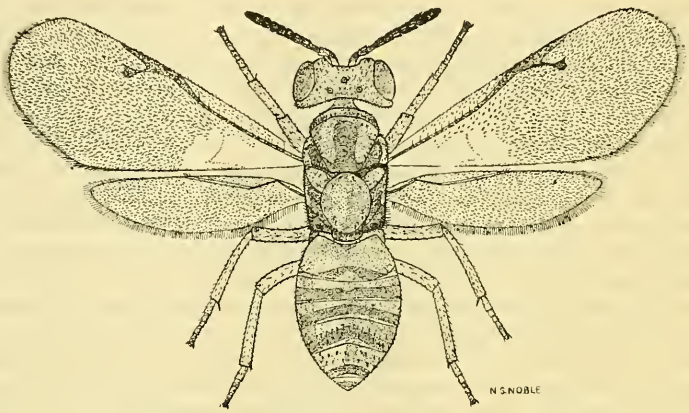

Fig. 1.—*Tepperella trilineata.* Adult female, × 15.

are reddish-brown, the antennae are dark brown and the head is mainly yellow with the tips of the mandibles dark brown. The back of the head is black. The base of the scutum is black and a variable central broad band on the scutum is black. This band may extend to the narrow pronotum or it may terminate before it, and its width is variable.

The dorsal surface of the pronotum is black and the ventral surface yellow. A fairly large proportion of the parapsides are black adjoining the scutum. The axillae on their outer margins and where they adjoin the scutum are black, the remainder being yellow. The scutellum is yellow with the hind margin black, the rest of the thorax being black. The legs are yellow, and the head, thorax and legs bear dark brown or black setae which stand out conspicuously. On the scutellum there are ten such setae, five being on each side in two somewhat irregular rows.

The dorsal surface of the abdomen consists of a series of black and yellow bands, with the tip of the abdomen black. Ventrally and distally the abdomen is black with the basal half yellow, the amount of black colouring on the abdomen and also the thorax differing considerably in different individuals.

♂.—The male is not mentioned in the original description, and, on account of the remarkable sexual dimorphism exhibited in this species, the male could easily be superficially mistaken for another species.

The average length of the male is 2·24 mm., the maximum being 2·45 mm. and the minimum 1·98 mm. It is, thus, on an average, approximately half a millimetre shorter than the female, but the male is very much less robust, this being particularly true of the abdomen, so that in general appearance the male is a very much more slender insect than the female.

The eyes of the male are reddish-brown, the antennae are brown and the remainder of the head and the thorax are black. The abdomen varies from brown to dark brown. The coxae and the distal half of the last segment of the tarsus and the tarsal claws are dark brown or black, the remainder of the legs being yellow. The wings are fuscous.

Other Morphological Characters of the Adult.

The stigmal knob (Fig. 2*c*), antenna (Fig. 2*b*) and mandible (Fig. 2*f*) of the female, the antenna (Fig. 2*a*) of the male and the tips of the stylet (Fig. 2*d*) and ovipositor sheath (Fig. 2*e*) of *T. trilineata* are illustrated. It will be noted that the tip of the stylet, though sharp pointed, bears no barbs, nor are any barbs present on the tip of the ovipositor sheath.

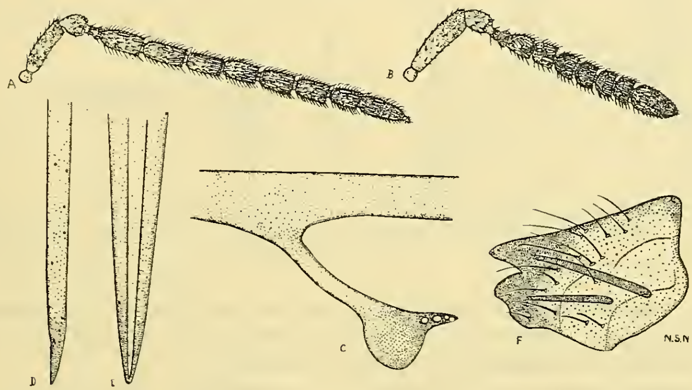

Fig. 2.—*Tepperella trilineata*. A, Antenna of male, × 36; B, Antenna of female, × 36; C, Stigmal knob of female, × 103; D, Lateral view of ovipositor stylet, × 180; E, Ventral view of ovipositor sheath, × 180; F, Mandible of female, × 103.

The Egg.

On dissecting the abdomen of a newly-emerged female, eggs floated out in large numbers in the dissecting solution, and could readily be studied.

Females were also enclosed in small tubes with acacia flower buds and as soon as oviposition occurred the buds were dissected and the newly deposited eggs were then examined.

The ovarian egg (Figs. 3*a*, *b*, *c*, *d*) is white in colour and consists of two oval bodies joined by a narrow connecting tube. In the earlier stage of development this tube is folded so that the two bodies lie near one another, but prior to deposition this tube becomes extended (Figs. 3*c*, 3*d*). The surface of the egg is smooth and unornamented. Immediately after deposition it is found that all the protoplasmic contents have passed into one end of the egg (Figs. 3*e*, 3*f*). The newly deposited egg, which is white in colour, consists of an oval body with a long flaccid pedicel. The presence of a long pedicel on the eggs of Chalcids has often been noted, but in *T. trilineata* the development of this pedicel has been carried to such a stage that the pedicel is just as voluminous as the main body of the egg.

As the protoplasmic contents all pass to one end of the egg after deposition, there is little doubt that this double-ended egg development is a device for facilitating the passage of the egg down the narrow ovipositor.

Bilobed ovarian eggs occur in some species of Chalcids, but the great length of the narrow connecting tube in *T. trilineata* is unusual. A somewhat similar type of egg has been described by Smith and Compere (1928) in *Metaphycus*

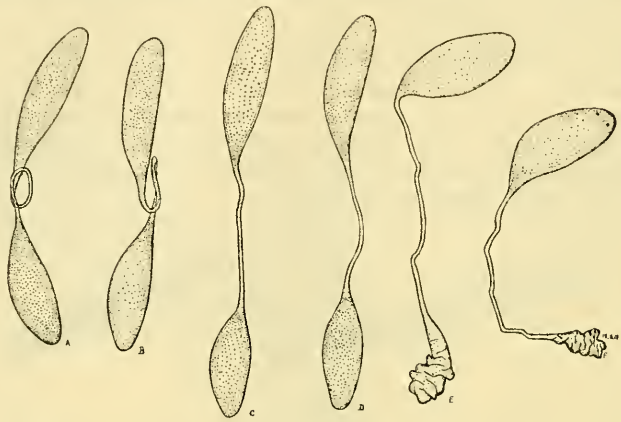

Fig. 3.—*Tepperella trilineata.* A, B, Ovarian eggs with connecting tube folded; C, D, Ovarian eggs with connecting tubes extended; E, F, Eggs just after deposition. All × 103.

lounsburyi, a parasite of the black scale, *Saissetia oleae*, but in this instance the elongate pedicel, after deposition, serves as a respiratory tube for the larva and projects through the integument of the scale insect.

The detailed dimensions of the egg of *T. trilineata* are set out in Table 1.

TABLE 1.

Dimensions of egg of Tepperella trilineata (*in millimetres*).

	Eggs dissected from ovaries.						Connecting tube.		Eggs immediately after deposition.	
			Larger body.		Smaller body.					
	Length with connecting tube folded.	Length with connecting tube extended.	Length.	Width.	Length.	Width.	Length.	Width.	Body Length.	Body Width.
Average	0·400	0·506	0·179	0·050	0·138	0·051	0·190	0·004	0·168	0·071
Maximum	0·432	0·521	0·185	0·053	0·142	0·053	0·205	0·004	0·186	0·078
Minimum	0·368	0·498	0·172	0·033	0·132	0·046	0·185	0·004	0·156	0·055

The Larva.

Based on the arrangement of the setae and papillae on the head, the size and shape of the mandibles, the number and size of the spiracles, and the distribution of setae on the body segments, it is evident that there are five larval stages.

Parker (1924) stated that in species of the family Perilampidae there were four larval stages including the first or "planidium" or roving stage.

Dr. A. B. Gahan informed the writer that in his opinion these Australian gall-forming Chalcids form an analogous group and that their present systematic placement is unsatisfactory, and that a special group will probably have to be erected for them. Gahan's opinion has been arrived at from taxonomic studies, and the present biological studies of the writer lend further support to Gahan's opinion.

Stage I.—The first stage or primary larva (Fig. 4) is more or less translucent, with the contents of the alimentary tract bright green. It consists of a head and thirteen segments, but segmentation is not distinct. The head is hemispherical in outline, and is much narrower than the anterior abdominal segments and is relatively inconspicuous. The second and third abdominal segments are the widest portion of the larva, but it is more or less cylindrical and straight and narrows only slightly in the posterior segments. The mandibles are very minute, pale amber, more or less triangular in outline and average 0·008 mm. in length, and their tips overlie one another (Fig. 8*a*). The average width, between the two anterior tentorial rami (Vance and Smith, 1933), is 0·040 mm. The integument of

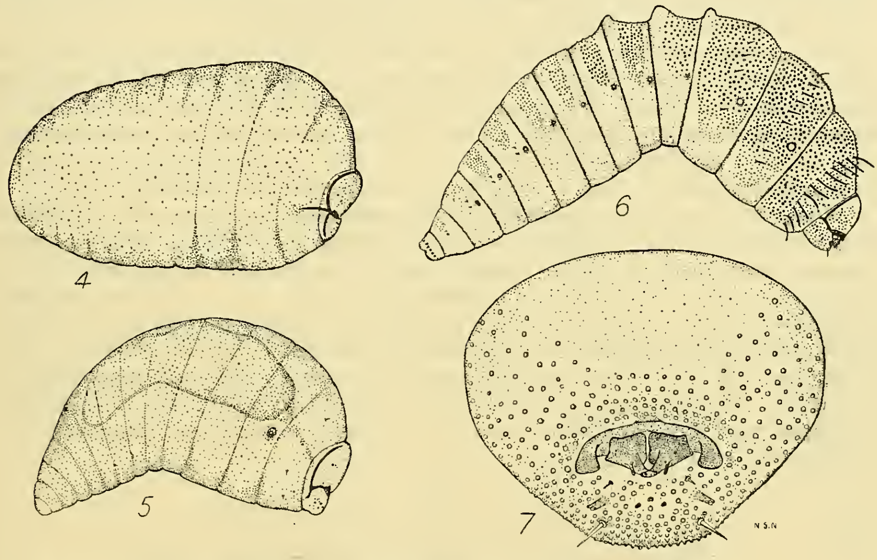

Fig. 4.—*Tepperella trilineata*. Lateral view of first-stage larva, × 180.
Fig. 5.—*Tepperella trilineata*. Lateral view of third-stage larva, × 55.
Fig. 6.—*Tepperella trilineata*. Lateral view of mature larva, × 20.
Fig. 7.—*Tepperella trilineata*. Front view of head of mature larva, × 103.

the body is smooth and glistening and free of spines. On the underside of the head are five minute sensillae, but no setae are present. There is no evidence of any respiratory system.

The smallest larva measured was 0·19 mm. in length and 0·08 mm. in width, being just visible to the unaided eye.

Stage II.—In colour and shape the second stage larva is remarkably similar to that of the first stage, but the two can be distinguished in a number of ways. The smallest larva measured was 0·22 mm. in length and 0·17 mm. in width. The mandibles (Fig. 8*a*) are amber in colour, more or less triangular in outline, with one sharp point. They average 0·016 mm. in length. In addition to the papillae below the mouth, two minute lateral setae are distinguishable and these average 0·003 mm. in length. There are no setae on the abdominal segments, but there is now a limited respiratory system present. This consists of a pair of longitudinal tracheal trunks, a few minute branches and one pair of open spiracles situated on the second segment and averaging 0·01 mm. in diameter.

The width between the two anterior tentorial rami is 0·109 mm. or about three times the width of stage I.

Stage III.—The third stage larva (Fig. 5) is somewhat translucent to light green in colour, cylindrical, arched and tapering to both ends. The smallest larva measured was 0·40 mm. in length and 0·22 mm. in width. It consists of a head and thirteen clearly defined segments. The mandibles (Fig. 8*c*) are amber in colour, much the same shape as those of the second stage. Their average length is 0·023 mm., the maximum being 0·026 mm. and the minimum 0·021 mm. A limited number of extremely minute papillae are to be seen on the ventral surface of the first abdominal segment. Sensillae are present beneath the mouth as in the second stage, and there is also a lateral pair of setae which are 0·006 mm., or just twice the length of those present in the second stage.

On the first segment there is a median circlet of very short straight setae, the number being variable, their average length being 0·017 mm. The remaining segments bear no setae. The respiratory system is very similar to that of the second stage, there still being but one pair of open spiracles on the second segment, their average diameter being 0·018 mm. In the more advanced larvae of this stage a pair of spiracles can be seen developing on the third segment.

Stage IV.—The fourth stage larva is greyish-green in colour, with the region of the alimentary tract darker green. Towards the close of this stage the larva becomes more white in colour, mainly due to the presence of fat body. It is cylindrical, arched and tapering towards both ends, and in general outlines resembles the larva of the last stage. It consists of a head and thirteen segments. The smallest larva measured was 0·58 mm. in length and 0·32 mm. in width. The mandibles (Fig. 8*d*), which are dark amber in colour, are more or less triangular in outline with very broad bases and one pointed, curved and more heavily chitinized tooth. Their average length is 0·039 mm., the maximum being 0·046 mm. and the minimum 0·036 mm.

TABLE 2.
Length of life of Tepperella trilineata *in laboratory.*

Length of life in days.	Number of Females.	Number of Males.
1	1	6
2	15	17
3	16	21
4	28	42
5	44	44
6	25	44
7	31	31
8	40	19
9	30	18
10	11	6
11	3	1
12	4	—
13	1	1
14	1	—
Total	250	250

Average length of life of male wasps, 5·48 days; female wasps, 6·34 days.
Maximum length of life of male wasps, 13·0 days; female wasps, 14·0 days.
Minimum length of life of male wasps, 1·0 day; female wasps, 1·0 day.

Below the mandibles and a little above them, the integument bears a number of minute papillae. Similar papillae can be distinguished on the first and second segments, but they can only just be seen with the highest power of the microscope on the second abdominal segment, and if present on the posterior segments, they are too minute to distinguish. On the head and below the mandibles there is a pair of minute setae and below these a pair of minute truncate cone-shaped structures, between which there are three oval sensillae and below these again there is a pair of longer setae, their average length being 0·017 mm.

On the first segment of the abdomen there is a median circlet of straight setae, the number usually being sixteen. The length of these setae varied on different larvae, the largest being 0·036 mm. in length and the smallest being 0·025 mm. in length. There are six shorter setae on the second segment, these being dorsal and lateral, and there are four minute lateral setae on the third segment. On segments nine to twelve there are two extremely minute lateral setae and on the last segment there are at least four.

There is further development of the respiratory system in this stage. In the more advanced larvae nine pairs of spiracles can be seen developing, but the first and second pair are larger than the rest and these are the only two which appear to open during this stage. The tracheal branches passing to the various organs are now more numerous.

Stage V.—The fifth or last stage larva (Fig. 6), which is white in colour, is cylindrical and arched, and tapering towards both ends. The average length of the mature larva is 3·25 mm., the average width being 0·84 mm. The dimensions of the largest and smallest larvae measured are set out in Table 3.

TABLE 3.

Dimensions (in millimetres) of various larval stages of Tepperella trilineata.

Stage of larva.		Length.	Width.
Stage I	Largest	0·28	0·17
	Smallest	0·19	0·08
Stage II	Largest	0·53	0·30
	Smallest	0·22	0·17
Stage III	Largest	0·77	0·32
	Smallest	0·40	0·22
Stage IV	Largest	1·04	0·40
	Smallest	0·58	0·32
Stage V	Largest	3·39	1·09
	Smallest	0·75	0·35

It consists of a head and thirteen segments, the head being rather inconspicuous and narrower than the anterior abdominal segments. Dorsally on the third, fourth and fifth segments there are ridges which become less prominent as the larva matures. Below and for some distance above the mandibles on the head (Fig. 7) and all over the surface of the first segment and laterally and dorsally on the succeeding segments, there are large numbers of rounded papillae, which become smaller and less numerous and more confined to the dorsal surface on the posterior segments.

On the first segment there is a complete girdle of long setae (Figs. 8*e*, *f*, *g*), which arise from papillae, which are chitinized, amber in colour, variable in number, and have the tips truncate. The setae on the first segment are frequently curved in outline, and vary somewhat in length, even on the same larva, but their length on different larvae varies greatly. Their average length on different larvae was found to be 0·098 mm., the maximum being 0·139 mm. and the minimum 0·059 mm. On the second and third segments a large number of setae are present, but they are much shorter than those on the first segment, their tips are not truncate, and they are borne dorsally and laterally, but not ventrally. On the fourth to the seventh segment inclusive, there are no setae. Occasionally on the eighth segment there is one short seta in the vicinity of the spiracle, and on segments nine to twelve, inclusive, there are commonly two pairs of short lateral setae, but the number on each side may vary from one to three. On the thirteenth segment there is a conspicuous girdle of short setae. A depression on the thirteenth segment marks the position of the anus. The first three segments are conspicuously wider than the succeeding ones. The head is more or less semicircular in outline (Fig. 7), and is more heavily chitinized than the remainder of the larva.

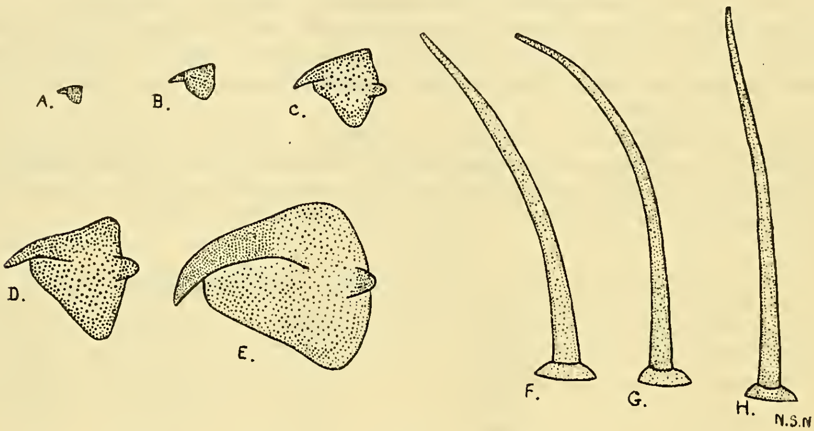

Fig. 8.—*Tepperella trilineata.* A, Mandible of first-stage larva; B, Mandible of second-stage larva; C, Mandible of third-stage larva; D, Mandible of fourth-stage larva; E, Mandible of fifth-stage larva; F, G, H, Setae from first segment of mature larva. All × 180.

The mandibles, the tips of which overlie one another, are light brown in colour, somewhat triangular in outline with one prominent curved more heavily chitinized tooth (Fig. 8*e*). They are variable in size, the average length being 0·064 mm., the maximum being 0·076 mm. and the minimum 0·056 mm. No evidence of antennae could be distinguished above the mandibles. Below the mandibles there is one pair of short setae and slightly below these, and more widely separated, is a pair of short truncate cone-shaped chitinized structures, the function of which is unknown. Below these there are three oval papillae, and below there is one pair of larger setae.

The tracheal system is now a complete and open one and consists of two well-developed longitudinal tracheal trunks extending down each side of the body, united anteriorly and posteriorly by short transverse trunks. Nine pairs of spiracles are present, being situated on the anterior part of each segment from two to ten, inclusive; the spiracles project slightly from the general body surface. The spiracles on the second segment are larger than any of those succeeding, while those on the third segment are extremely minute and appear to be almost non-functional. From the main tracheal trunks profusely branching tracheae pass out to the various body organs.

The dimensions of the smallest and largest larvae of the various stages measured are set out in connection with larval development in Table 3.

BIOLOGY.

Length of Life of Adults.

A total of 500 newly-emerged males and females of *T. trilineata* were placed in glass tubes six inches in length and one inch in diameter. One end of the tube was covered with cheese-cloth and the other was plugged with cotton-wool which was kept moistened with sugar and water solution. These were held in the laboratory and dead wasps were removed daily; the length of life of males and females under these conditions is set out in Table 2. Females lived slightly longer than males, but the length of life of both sexes was comparatively short.

In the spring of 1936 ten females were used to obtain oviposition records and were kept in tubes and provided with fresh acacia flower buds during their entire adult lives. The number of days these adults lived was as follows: 2, 2·5, 2·5, 3, 3·5, 4·5, 4·5, 4·5, 5, and 5, the average being 3·7 days, so that the life of ovipositing females is very short.

In the series of experiments mentioned in the introduction, in which many hundreds of newly-emerged adults were enclosed on acacia branches in cellophane sleeves, many died during the first twenty-four hours, and it was exceptional to find any adults living after the fourth day.

Habits of Adults.

Both sexes are somewhat inactive as compared with the other species in the galls. They tend to walk rather than fly and can readily be transferred in the laboratory by means of a camel-hair brush. During the heat of the day in the open, they are fairly active, and have been observed flying in large numbers around the tree bearing the galls from which they emerged. They are not strong fliers and soon settle after taking to the wing. At night they have been found sheltering in flower-buds or beneath leaves. When confined in glass tubes they have sometimes been observed feeding on sugar and water solution, but they are not particularly attracted to this food.

Percentage of Sexes.

Of a total of 1,058 adults of *T. trilineata*, which emerged from galls in the spring of 1936, 525 or 49·62 per cent. were females and 533 or 50·38 per cent. were males, the ratio of sexes being therefore remarkably even.

Mating.

T. trilineata does not mate readily in the laboratory. Although 500 individuals of both sexes were enclosed in tubes, six inches long and one inch in diameter, when determining the length of life it was only on rare occasions that fertilization was observed. Even when females known to be unfertilized were enclosed with males in very small vials, the two sexes were not attracted to one another. Fertilization was observed on a number of occasions, but there was nothing unusual worthy of record. In one instance the contact lasted thirty-five seconds.

Oviposition.

At the time the first adults of *T. trilineata* emerge only the more advanced flower buds are showing and these are so small that only microscopic examination indicates their nature. The complete inflorescence at this time consists of one minute compact mass, which will eventually separate into a number of globular green flower-heads, each on a short stalk. The females oviposit in these flower buds, but never display any interest in the inflorescence once the individual globular flower-heads have become separated from one another.

Whether fertilized or unfertilized, immediately upon eating their way out of the galls, females may commence to oviposit. Adults which emerged from pupae dissected and placed in petri dishes, on dissection were found to contain very few mature eggs, while females dissected immediately after emerging from galls were found to have the majority of the eggs mature. Evidently, as the writer (Noble, 1936) found in *Eurytoma fellis* in citrus galls, the adults take some days to eat their way out of the galls and during this period the eggs mature, and the wasp is able to lay large numbers of eggs during the first day of emergence.

The ovipositing female, on coming into contact with a suitable flower bud (Plate xx, fig. 1) becomes very excited and, for a few moments only, plays the tips of the antennae over the surface of the bud. Without inflexing the abdomen the wasp independently thrusts the ovipositor from beneath the guards and brings it down at right angles to the body, so that its tip rests on the surface of the bud. It experiences little difficulty in penetrating the plant tissues, but for the earlier part of the oviposition period the ovipositor is only partly embedded. Later the ovipositor is moved up and down; the abdomen is moved from side to side and the ovipositor is then embedded more deeply and, before finally withdrawing it, the wasp remains motionless for a few moments. Usually on withdrawing the ovipositor the latter is not replaced within its guards, but is held down at right angles to the body, with its tip poised just above the plant tissues. The wasp then moves slightly forward and again penetrates the bud and lays another egg, the ovipositor being again withdrawn, and the process repeated. Unsuccessful attempts to oviposit, accompanied by a partial embedding of the ovipositor, were rarely observed, and in the laboratory the female usually oviposited almost continuously for some hours without leaving the buds to rest. Two females under observation oviposited continuously for four and three-quarter hours, and five and one-quarter hours, respectively, and both were actively ovipositing on the following day. The time occupied in individual ovipositions, both by the same and by different females, varied considerably, the recorded times of eight ovipositions being 6, 8, 2, 3, 2, 6, 2, and 3 minutes.

It is of interest to note that once the female has discovered a suitable bud-mass by means of the antennae, the latter appendages are seldom again utilized, while the female remains ovipositing on that particular bud-mass.

A number of eggs is laid in each globular flower-head, and each one of these minute globular heads eventually forms a gall. Five globular heads were dissected and found to contain 6, 5, 8, 7 and 5 eggs respectively; one flower-bud which measured 0·75 mm. in diameter contained five eggs. The eggs in many instances are separated slightly from one another, but frequently eggs are touching.

Ten females were confined in tubes from emergence until death and were regularly supplied with fresh acacia buds in which to oviposit. In all cases eggs were laid until within a few hours of death, the average length of the oviposition period being 3·5 days, with a maximum of 5 days and a minimum of two days. In all but one case, dissection showed that the dead females contained large numbers of apparently normal eggs.

As the first adults emerged on 7th September and the last emergence occurred on 12th October, 1936, and the maximum length of life was only fourteen days, the total period of oviposition in 1936 was almost two months, and terminated about the end of October. Throughout the latter half of September and the first half of October, 1936, females were observed in large numbers, on sunny days, flying about the galled tree or ovipositing in the minute flower-buds.

Total Eggs Within Females.

Ten newly-emerged females were dissected and were found to contain the following numbers of eggs: 495, 519, 552, 561, 456, 542, 565, 461, 611, 578, the average number being 534, which is considerably more than the number of eggs present in any other species of Chalcid previously studied by the writer.

Incubation Period.

As with other gall species, it is impossible to determine accurately the incubation period, as dissection of the egg from the plant tissues results in its destruction. Observations must therefore be of an indirect character.

On 4th October, 1936, twenty-seven days after the first adult of *T. trilineata* emerged, a number of the more advanced acacia buds were dissected and, while mostly eggs were found, one minute first-stage larva was dissected, while in several eggs fully-developed larvae could be seen. The incubation period of this larva was at most twenty-seven days.

On 19th October, 1936, six weeks after the first adult emerged, many eggs and first stage larvae were dissected from acacia buds and some of these larvae were considerably larger than those dissected two weeks earlier.

Larval Development.

It has already been pointed out, when discussing the morphology, that there are five larval stages. The first-stage larva, on first hatching, is somewhat arched and flaccid, but as it feeds and increases in size (Fig. 4) it becomes straight in outline and the head becomes relatively inconspicuous. At no stage do the larvae possess any powers of locomotion, but all twist and turn slowly when dissected from the plant tissues. On changing to the second stage the larva becomes longer in proportion to its width. The earlier stages are semi-translucent with the region of the alimentary tract green, due apparently to the green cell contents of the nutritive layer on which these larvae feed. In the fourth stage, and particularly in the fifth or last larval stage, fat-body develops so that eventually the stomach contents are so masked that the larva appears to be white in colour.

In the earlier stages the stomach is a blind sac and the alimentary tract does not open to the exterior until the larva reaches maturity, and any waste matter is voided prior to pupation. On mounting larvae of the last stage it is quite common to find the mandibles and cast skins of all the preceding stages adhering to the integument.

During 1936 and 1937 large numbers of larvae of various stages were measured. In Table 3, the dimensions of the largest and smallest larvae of the various stages are set out. As with other larvae studied by the writer, the amount of growth during the fifth stage is outstanding.

There is considerable overlapping of size in the various stages, some of the immature larvae of any stage being smaller than fully-fed larvae of preceding stages. Adult females of *T. trilineata* are much larger than male adults, and the smaller measurements are probably, in many cases, those of larvae which would have given rise to males.

In Table 4 is set out the result of the periodic dissections of galls on *Acacia decurrens* at Lindfield in 1936 and 1937. As the adults of the gall former, *T. trilineata*, emerge each year in September and October, the figures in the table represent observations on two generations of larvae.

TABLE 4.

Results of dissections of Galls on Acacia decurrens *throughout a period of sixteen months (May. 1936–September, 1937) showing stages of* Tepperella trilineata *present.*

Date of dissection.	Number of cells containing *T. trilineata* examined.	Stage I.	Stage II.	Stage III.	Stage IV.	Stage V.	Number of prepupae.	Number of pupae.	Number of adults.	Remarks.
						1935–36 Galls.				
11/5/36	15	—	1	1	12	1	—	—	—	
16/5/36	8	—	—	—	3	5	—	—	—	
27/5/36	25	—	—	—	22	3	—	—	—	
5/6/36	11	—	—	—	—	11	—	—	—	
19/6/36	1	—	—	—	—	1	—	—	—	
26/6/36	13	—	—	—	—	13	—	—	—	
3/7/36	5	—	—	—	—	5	—	—	—	
8/7/36	25	—	—	—	—	25	—	—	—	Only 3 mature.
11/7/36	17	—	—	4	1	11	1	—	—	
16/7/36	14	—	—	3	2	9	—	—	—	
26/7/36	35	—	—	—	—	30	5	—	—	
28/7/36	17	—	—	—	1	13	2	1	—	
3/8/36	21	—	—	—	—	—	8	13	—	
9/8/36	26	—	—	—	—	13	7	6	—	
12/8/36	24	—	—	4	2	18	—	—	—	
18/8/36	21	—	—	—	—	—	—	21	—	
22/8/36	27	—	—	—	—	—	8	19	—	
30/8/36	40	—	—	—	—	—	9	30	1	
6/9/36	45	—	—	—	—	2	—	40	3	
9/9/36	13	—	—	—	—	—	—	12	1	
13/9/36	23	—	—	—	—	—	—	14	9	First emergence holes present.
20/9/36	12	—	—	—	—	—	—	2	10	Large number of emergence holes present.
27/9/36	12	—	—	—	—	—	—	1	11	
*4/10/36	8	—	—	—	—	—	—	4	4	
						1936–37 Galls.				
27/9/36	Not counted	—	—	—	—	—	—	—	—	Eggs only.
4/10/36	,,	1	—	—	—	—	—	—	—	Large number of eggs present.
19/10/36	,,	3	—	—	—	—	—	—	—	
29/11/36	,,	4	—	—	—	—	—	—	—	A few eggs present.
5/12/36	,,	†	—	—	1	—	—	—	—	No eggs.
14/12/36	6	4	1	1	—	—	—	—	—	
9/1/37	4	3	1	—	—	—	—	—	—	
16/1/37	8	6	2	—	—	—	—	—	—	
1/2/37	7	7	—	—	—	—	—	—	—	
15/2/37	6	2	4	—	—	—	—	—	—	
9/3/37	11	—	6	1	2	2	—	—	—	
2/4/37	9	—	1	8	—	—	—	—	—	
20/4/37	13	—	—	12	1	—	—	—	—	
7/5/37	26	—	1	14	10	1	—	—	—	
1/6/37	15	—	—	1	11	3	—	—	—	
29/6/37	38	—	—	1	2	35	—	—	—	
15/7/37	29	—	—	—	—	29	—	—	—	
6/8/37	17	—	—	—	—	14	3	—	—	
13/8/37	46	—	—	—	—	40	2	4	—	
30/8/37	27	—	—	1	—	10	1	15	—	
14/9/37	13	—	—	—	—	—	—	12	1	
16/9/37	79	—	—	—	—	—	—	72	7	

*1936 First adult of *T. trilineata* emerged 7th September.
1936 Last ,, ,, ,, ,, 12th October.
1937 First ,, ,, ,, ,, 19th September.

On 11th October, 1936, 106 gall cells were examined and on 18th October, 1936, a further 153 cells were examined, but no adults of *T. trilineata* were found.

†Large number.

The Pupal Stage.

On first pupating the female pupae are white, but change within a few days to shining black. The average length of the female pupa is 2·61 mm., the maximum being 2·76 mm. and the minimum 2·45 mm.

Male pupae are to be found in much smaller cells scattered through the galls, the plant tissues fitting closely up against the integument of the pupa. Sometimes these male cells have a very thin layer of plant tissue separating them from the exterior, but frequently they are deep down within the galls, usually in close proximity to much larger cells containing the females.

Male pupae at pupation are creamy-white, their average length being 2·04 mm., the maximum being 2·19 mm. and the minimum 1·79 mm. Unlike the female, they do not change colour rapidly during the pupal period. The colour remains creamy-white for approximately three weeks. The antennae then become amber; the eyes turn reddish-brown, the remainder of the pupa becoming pigmented only a few days before emergence, the general colour then being dark-brown with alternating light and dark brown bands on the abdomen. Unlike the female, the male pupa never becomes black.

In 1936 the first pupa of *T. trilineata* was found in a gall on 28th July, and it subsequently emerged on 20th August, eighteen days before any adults ate their way out of the galls. In the spring of 1936 large numbers of prepupae were dissected from galls and placed in petri dishes, a high humidity being maintained by placing a large saturated cotton-wool plug in the dish. Most of these prepupae died, but four pupated and later emerged as adults, the pupal periods being 37, 41, 38 and 40 days, the average being 39 days.

Four pupae of *T. trilineata* were found in galls on 13th August, 1937, sixteen days later than the first pupa was found in the preceding year. The date of pupation of these individuals was, of course, not known, but it will be noted that there was also a difference of 12 days in the dates of first emergence of adults in 1936 and 1937.

In 1937 pupae were again dissected out of galls and held in petri dishes and three emerged as adults on 14th September, which is 25 days later than the first adult emerged, under these conditions, in 1936.

Emergence of Adults.

Adults emerge by cutting a cylindrical channel from the gall chamber to the exterior, leaving a regular circular hole on the gall surface.

In order to obtain seasonal emergence records, large numbers of galls were picked from the tree a few days before any adults emerged. These galls were placed in large tubes 8 inches in length and 1½ inches in diameter, and the end was plugged with cotton wool moistened with water. In these tubes the galls remained quite green and unshrivelled for several weeks.

In figure 9 is shown graphically the daily emergence of 1,058 adults of *T. trilineata* in the spring of 1936. The first emergence occurred on 7th September and the last on 12th October, the total emergence period being thirty-six days.

Early in the spring 200 pupae of *T. trilineata* were dissected from galls and placed in petri dishes and the first of these emerged as an adult on 20th August, eighteen days before the first adult emerged from the galls. An adult was also found in a gall on 30th August, 1936, eight days before any adults ate their way out, so it is evident that the adults on emerging from the pupal stage require some days to cut their way out of the galls. In 1937 the first adult emerged from galls on the same tree on 19th September, which was twelve days later than in the preceding year.

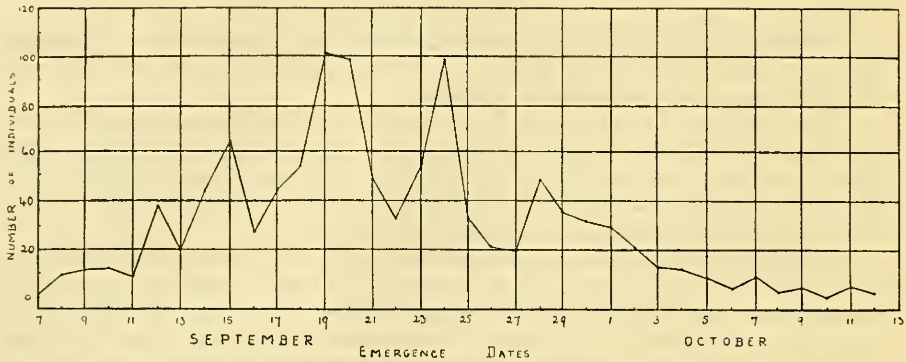

Fig. 9.—Graph showing emergence of 1,058 adults of *Tepperella trilineata* at Lindfield, Sydney, in the spring of 1936.

Natural Mortality.

Occasionally in dissecting galls in the late winter and spring of 1936 cells were found in which dead larvae or pupae of *T. trilineata* were present, while on a number of occasions dead adults of both sexes were found in cells, no attempt having been made, after passing from the pupal stage, to eat their way out of the galls.

Time Spent in the Various Stages of the Life Cycle.

In Table 4 are set out the results of the dissections of galls in 1936 and 1937, and as the adults emerge in September and October, these figures represent observations on two generations of *T. trilineata*, those of 1936–37, covering the complete life-cycle of this generation. The figures indicate the progressive development of the various stages of the insect.

It will be seen that first-stage larvae were present from 4th October, 1936, to 15th February, 1937, a period of almost four and a half months, a considerable period, but far less than the writer (Noble, 1936) found in the citrus gall wasp, *Eurytoma fellis*. In that species, though adults emerged annually and in the spring, the larvae of *E. fellis* remained in the first larval stage for a period of eight months.

Second-stage larvae were present from 14th December, 1936, to 7th May, 1937, a period of more than four months, and the last second-stage larva was found in the previous generation as late as 12th August, 1936, so it is evident that the length of time spent in this stage is very variable.

Third-stage larvae were first found in the galls on the 14th December, 1936, and in the previous generation were present until 12th August, 1936, and one was also found on 30th August, 1937.

Fourth-stage larvae were first found on 5th December, 1936, and in the previous generation they were present until 12th August, 1936.

In the case of the last stage, the first larva was found on 9th March, 1937, and larvae of this stage were present until 30th August, 1937. In the previous generation of galls they were present from 11th May, 1936, the first date on which detailed observations were made, until 6th September, 1936, a few days before the first adults emerged. All fifth-stage larvae dissected on 26th July, 1936, and subsequently, were mature.

It is therefore evident that, as in the second stage, there is very great overlapping in the periods spent in the third, fourth and fifth larval stages. The immature larvae, which were occasionally dissected long after the majority of the same stage were found, were taken from very minute galls, and it is doubtful if these larvae would ever have matured.

Allowing for a twelve-months life-cycle, an incubation period of approximately four weeks and a pupal period of almost six weeks, it is evident that the larval period extends over a period of approximately ten months, being, as with the citrus gall wasp, *Eurytoma fellis*, by far the longest period of the life-cycle.

Observations on the Development of the Galls.

In *Acacia decurrens* the inflorescence consists of a number of globular flower-heads, each head or "ball" consisting of a number of flowers.

At the first appearance of the flowering buds these bright green globular flower-heads are close together, forming a compact mass (Plate xx, fig. 1), but just prior to flowering each globular head separates from its neighbour and is attached by a short stalk to the main stem of the inflorescence.

It has already been stated that in 1936 the emergence of *Tepperella trilineata* commenced on 7th September, and continued until 12th October. On 7th September that year the more advanced flower buds were just beginning to appear.

By 27th September a large number of flower buds were present and in the more advanced inflorescences, the individual flower-heads had separated out, but in the majority the globular flower-heads still formed one compact mass.

By 11th October, most of the globular flower-heads had separated from one another, but no flowers were present and there were still a few buds in which the globular flower-heads formed a compact mass, but this was exceptional. It is worthy of note that the last adult of *T. trilineata* emerged on the following day.

By 18th October there was still no sign of flowers, but most of the individual globular flower-heads were separated from one another on the inflorescence. Though it was forty-one days since the first adult gall-wasp emerged and oviposited and the incubation period that season was slightly less than four weeks, there was no observable sign of distortion of any of the buds.

A thorough inspection of the tree on 25th October showed general conditions exactly as they were one week before, there being no sign of flowering or evidence of galling of any of the globular flower-heads.

On 1st November conditions were much the same and on 8th November, while no flowers had yet appeared, most of the globular flower-heads were now very large and conspicuous and mainly separated from one another.

On 11th November no flowers were seen, but on the following day, 12th November, a little more than two months after the first flower-buds were noticed, the first globular heads bloomed, and by 15th November a number of the conspicuous golden heads were to be seen on different parts of the tree, but at this time only a small number of the inflorescences were in full bloom.

The individual flowers comprising a globular head pass out from a minute fleshy green base to which the flower stalk is attached. At this time it was noted that in some flower heads this fleshy base was slightly more prominent than usual and that in these only a small number of flowers, notably those most distant from the base, had flowered, and on dissection of the fleshy green zone, first-stage larvae of *T. trilineata* were found. Thus this abnormal flowering of certain buds provides the first indication that they are infested.

By 22nd November the tree was half in bloom and many of the earlier flower-heads had already shrivelled and fallen. By 29th November the tree was in full bloom, but there were still many buds to come out.

It was noted that in many inflorescences, though a high percentage of the flowers had shrivelled and fallen, those in which flowering had been abnormal and which were infested by *T. trilineata* remained attached to the flowering stems.

By 6th December the tree was past full bloom, but there were still many buds to open and the tree still presented a golden appearance.

On 13th December the tree was still in flower, but most of the buds had opened, and by 18th December, 1936, the tree had finished flowering, a few faded globular heads were still on the tree, but there were no further buds to open.

The distorted flower-heads in which *T. trilineata* larvae were present, though still quite small, had increased in size somewhat, and were readily observed, attached to the more or less bare flower stems, from which the normal flowers had fallen.

Thus the tree during 1936 was in flower for a period of five weeks and finished flowering approximately three and a half months after the first flower-buds were noticed. In 1937 the first blossom appeared on this tree, on 4th November, which was some days earlier than in the preceding year, and a few blossoms were still present on 20th December, 1937, which was also slightly later than in the preceding year, so that the flowering period in 1937 was somewhat more protracted than in 1936.

The first trace of abnormality in the flowers was noticed in flowers on 15th November, 1936, which was sixty-nine days after the first adult of *T. trilineata* emerged and oviposited. As the incubation period was about four weeks in 1936, it is evident that there are no external or internal signs of distortion of the plant tissues while the insect is in the egg stage, and that there is no readily external visible indication of the insects' presence until some weeks after the larvae have hatched.

By the beginning of January, 1937, though the remains of the flowers were visible on the infested globular heads (Plate xx, fig. 2), very definite but minute galls were present.

From general observations over a number of years, it is evident that after the tree finishes flowering and the gall-wasp larvae hatch, the galls continue to increase steadily in size during the remainder of the summer and the following autumn (Plate xx, fig. 3). The galls during this period are bright green and continue to increase in size during the winter, and in the late winter the surfaces of many of the larger galls become tinted with red, but the smaller galls are still bright green (Plate xx, figs. 4 and 5).

The galls showing this red or rosy tint do not increase further in size, and dissection shows them to contain mature or maturing larvae. Thus in *T. trilineata* gall development continues throughout the entire larval period from hatching to pupation. In this respect it differs markedly from *Eurytoma fellis* which causes galls on citrus stems (Noble, 1936). In this case the galls reach their full size while the insect is still in the first larval stage.

On 4th July, 1936, the first mature larvae of *T. trilineata* were found and several were passing to the prepupal stage, and the first pupa was found on 27th July, 1936. At this time galls containing mature larvae and prepupae or pupae were showing the red tint, at least on part of their surfaces.

The surfaces of some of these maturing coloured galls are rough and they are very irregular in shape, while others, particularly the smaller ones, are round, with the surface smooth (Plate xx, figs. 4 and 5). Some of these small round galls were immature at the end of July in 1936, but in others the small size was due to the fact that they contained but one cell.

During the first two larval stages the plant tissues fit closely against the integument of the larvae, but, with the commencement of the third stage, there is a small space between the inner walls of the gall cell and the integument of the larva. This space increases in volume as the larva develops, so that by the time the larva reaches the fifth stage and matures, there is usually quite an appreciable space between the wall of the cell and the host larva. The size of the gall cell or chamber varies greatly, and may be just a little bigger than the mature larva but more commonly is several times the volume of the latter.

During the summer and autumn the galls when cut are found to be very soft and the cells of the nutrient layer surrounding the larva are particularly soft, cut readily and contain a high percentage of liquid.

However, this nutrient layer becomes narrower as larval development progresses and by the time the larva matures it has disappeared and the larva has become surrounded by a narrow, but extremely hard woody layer, which can be cut only with difficulty with a razor. This is in marked contrast to the rest of the gall, which until the adults emerge remains quite soft and fleshy, the cells containing a high percentage of liquid. These outer layers of plant tissue can be readily removed with the finger nail, leaving a number of hard oval cores within which are the mature larvae or pupae.

A number of sections were cut through typical galls of various ages, the general arrangement of the tissues being somewhat the same as that illustrated by Imms (1925, p. 557, after Fockeu) in the gall of *Neuropterus lenticularis*, a cynipid gall wasp occurring in England.

Following the epidermal layer there is an extensive layer of parenchymatous tissue. This consists of numerous rounded thin-walled and large cells. In the maturing galls there follows a layer of smaller cells with very thick walls, and this constitutes the protective layer to which Imms refers. Particularly referring to cynipid galls, he stated that this protective layer is sometimes wanting. In the early stages of gall development in *Tepperella trilineata* the protective tissue cannot be detected as a special layer, but sections of galls in which the larvae are maturing, stained with safranin and Ehrlich's haematoxylin, show a definite protective layer stained a very much deeper red than the adjoining tissues, thus suggesting its woody character, and it is this zone which can be sectioned only with difficulty. Within this protective layer there is a layer of small but soft and highly fluid nutritive cells, the extent of this layer depending upon the stage of development of the larva in the particular cell.

During the course of the investigation all the cells in 731 galls were counted and amounted to 2,307, the average cells per gall being 3·16, the maximum being 11 and the minimum 1. Unilocular galls were quite common, but galls containing 8 or more cells were comparatively rare. The distance between the cells in the galls varied greatly, while the number of cells was not always reflected in the size of the gall. Thus on 15th September, 1937, two galls of equal size were examined, one being found to contain two pupae of *T. trilineata*, while the other contained five.

A typical unilocular gall is spherical or oval in outline, there being a fairly extensive layer of plant tissue surrounding the gall chamber, the latter being usually cylindrical in shape with rounded ends. There is, however, a considerable difference in the width of the plant tissues surrounding the gall chamber in unilocular galls.

In galls of two or three cells their presence is sometimes indicated by definite lobes, the gall being bi- or tri-lobed, but in most cases the general surface of multilocular galls is more or less regular.

Until most of the inhabitants of the galls have emerged the galls remain green in colour, and as adults of various species are emerging from some galls from early in September until the following January, some galls remain green throughout this period.

When most of the cells in a gall have been vacated the gall rapidly shrivels, turns black, and may fall from the tree soon afterwards, the entire twigs bearing these galls drying, turning black and becoming extremely brittle.

Some of these galls fall from the tree before the last adults of *Eurytoma* sp. have emerged, but the adults of this species later emerge from these hard, woody, fallen galls in a normal manner.

A few of the previous season's galls sometimes remain on the tree for many months, and at the time the first adults of *Tepperella trilineata* emerged in September, 1936, there were still a limited number of the vacated 1935 galls on the tree. On 9th November, 1937, there were also fair numbers of the previous year's galls present on this tree.

Insects Associated with Tepperella trilineata in the Galls on Acacia decurrens.

(A). *Hymenopterous species in the galls.*

It has already been pointed out that twelve wasp species emerged from these galls.

The fourth most abundant species was *Coelocyba nigrocincta*, a small yellow and black Chalcidoid which occurred in limited numbers only in these galls. In 1936, of a total of 3,511 adult wasps emerging, only 101 were *C. nigrocincta*. In the spring of 1937, in a total of 573 gall cells examined in one series of dissections, only 23 contained some stage of *C. nigrocincta*.

On a number of occasions in the spring of 1937, pupae of *C. nigrocincta* were removed from gall cells and examination of the cell debris revealed the mandibles of the last-stage larva of *Tepperella trilineata*. On three occasions unilocular galls were dissected in which the pupa or adult of *C. nigrocincta* was present together with the mature larval remains of *T. trilineata*. These galls were in general respects similar to unilocular galls in which *T. trilineata* was present alone.

It is evident that where *C. nigrocincta* is associated with *T. trilineata*, the latter species is able to reach the last larval stage, but the presence of *C. nigrocincta* results eventually in the death of the primary gall former.

Of particular interest is the discovery of the presence of a species of parasitic viviparous nematode within both sexes of the adults of *Coelocyba nigrocincta*, and it is intended to discuss this species further in another paper.

Eurytoma sp., which is the most common of all the species of wasps occurring in the galls, lays its eggs alongside the eggs or larvae of *T. trilineata*. The larvae of the two species occupy the same gall cell and feed phytophagously until the larvae of *Eurytoma* sp. reach the fifth or last stage, when they devour the larvae of *T. trilineata*.

The life-history of *Eurytoma* sp., which is most unusual, has been studied in detail, and will be set out in a separate paper.

Megastigmus sp., second only in abundance to *Eurytoma* sp., is an internal larval parasite of *Tepperella trilineata*, and its life history will be discussed in a separate paper.

In many cells in the galls the larvae of *T. trilineata*, *Megastigmus* sp., and *Eurytoma* sp. were all found to be present. In all such instances the larva of

Eurytoma sp. ultimately devours the larva of *T. trilineata* and any larvae of *Megastigmus* sp. which are within the larvae of *T. trilineata*.

(B). *Insects other than Hymenoptera in the Galls.*

(1) *Lepidopterous larvae.*

Few lepidopterous larvae were found until late winter, but then and in the early spring the occurrence of the larvae of a small moth mining through the galls was quite common.

In the larger galls in which the protective layer was well developed the larvae mined only through the softer parenchymatous tissues and did not then harm the occupants of the cells. However, in cells where the wasp larvae were less mature and the protective layer not so well formed, these moth larvae mined throughout the galls, devouring all but the outer gall layers, and destroying at the same time the various normal occupants of the gall cells.

(2) Myrmacicelus formicarius *Chev.*

During the winter of 1936 larvae of a Curculionid were found occasionally within the galls and in some instances these had devoured the greater part of the internal contents of the galls. Similar larvae later pupated within the mined galls, and on the emergence of the adults it was found to be the ant-like weevil, *Myrmacicelus formicarius* Chev. The first adult emerged on 8th October, 1936, and the last on 9th December, 1936. This species, which was described by Chevrolat (1833), is shining smooth and black and measures one-sixth of an inch in length. It has been figured and recorded by Froggatt (1902), who stated: "This is a queer-looking ant-shaped weevil that crawls about on the trunks and foliage of the wattle and is often taken in the net when sweeping a bush."

So far as the writer knows, the notes in the present paper are the first to throw any light on the life-history of this insect.

Summary.

The detailed life-history of *Tepperella trilineata* Cam., a perilampid wasp causing galling of the flower buds on *Acacia decurrens* var. *pauciglandulosa* in the Sydney district, is described.

The life cycle is annual. The adult wasps emerge from the galls in the early spring, mainly during the second half of September and the first half of October.

Of 1,058 adults which emerged in 1936, 525, or 49·62 per cent., were females and 533, or 50·38 per cent., were males.

There is remarkable sexual dimorphism, the males being dark brown to black, the females being bright yellow and black in colour.

Adults are very short lived, the average length of life of male wasps being 5·48 days and of female wasps 6·34 days.

The average number of eggs within ten females was 534, the maximum being 611 and the minimum 456.

Whether fertilized or not, females commence oviposition on the day of emergence.

The eggs, which prior to oviposition are remarkable bi-lobed structures joined by narrow connecting tubes, are inserted in the minute flower-buds, which are just commencing to appear on the tree at the time the first adult wasps emerge. After oviposition all the protoplasmic contents pass into one body of the egg.

Flower buds in an advanced stage of development are unsuitable for oviposition.

Five larval stages occur, and their detailed external morphology is described.

Each gall represents an aborted globular flower-head. Even though oviposition has occurred, a number of the upper flowers in the globular flower-head bloom, but the lower buds do not open. The galls do not become evident until several months after the larvae have hatched. The galls increase in size slowly throughout the summer and winter and reach their full size at the time the larvae reach maturity. The average number of cells in each gall was 3·16, the maximum being 11 and the minimum 1.

The incubation period is approximately 4 weeks, the larval period being approximately 42 weeks and the pupal period 6 weeks.

Eleven other species of wasps, of which nine were Chalcids, were also bred from the galls.

Limited numbers of a species of Bethylid and also a species of Braconid, which emerged from the galls, are thought to be parasites of lepidopterous larvae which were found commonly mining in the galls.

Of the Chalcids, two species outnumbered all others, viz., *Megastigmus* sp. and *Eurytoma* sp., the latter species outnumbering all others, including the primary gall-former, *T. trilineata.*

Megastigmus sp. is an internal parasite of the larva of *T. trilineata*, and it has an annual life cycle.

The life cycle of *Eurytoma* sp. is also annual.

The egg of *Eurytoma* sp. is laid alongside the egg or larva of *T. trilineata*, and the larvae of the two species live phytophagously in the same cell until the larvae of *Eurytoma* sp. reach the fifth or last stage, when they devour the larvae of *T. trilineata.*

Another species of Chalcid which emerged in small numbers from the galls was *Coelocyba nigrocincta*. It is of particular interest because in both sexes, parasitic viviparous nematodes were found to be present in the abdomen of both pupal and adult wasps. The larvae and pupae of the ant-like weevil, *Myrmacicelus formicarius* Chev. were also present in the galls, and limited numbers of the adults of this weevil emerged during the spring and summer.

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Galls on *Acacia decurrens* var. *pauciglandulosa* caused by *Tepperella trilineata*.